Comparison of Prevalence and Risk Factors for Microalbuminuria in South Asians and Europeans with Type 2 Diabetes Mellitus

H.M. Mather*[1], N. Chaturvedi[2], A.M. Kehely[1]

[1]*Ealing Hospital, Southall, Middlesex, UB1 3HW*
[2]*EURODIAB, Department of Epidemiology and Public Health, University College London, London, UK*

Although Type 2 (non-insulin-dependent) diabetes mellitus (Type 2 DM) is more common in South Asians than in Europeans in the UK, very little is known about complications and their risk factors in South Asians. We sought microalbuminuria in a cross-sectional study of 583 European and 889 South Asian Type 2 DM clinic attenders to Ealing Hospital, London, over 1 year. Albumin/creatinine ratios were measured in early morning urines. Prevalence of microalbuminuria was greater in South Asians compared to Europeans (40 % versus 33 % in men, $p = 0.003$, and 33 % versus 19 % in women, $p < 0.0001$). Glycaemic control was worse and prevalence of hypertension, retinopathy and heart disease was higher in South Asians. Key risk factors for microalbuminuria in both ethnic groups were glycaemic control, diabetes duration, blood pressure, triglyceride and retinopathy, but none accounted for the higher microalbuminuria prevalence in South Asians. Age and sex adjusted odds ratio for microalbuminuria was 1.78 (95 % CI 1.02, 2.82,$p = 0.02$) in South Asians versus Europeans. After adjustment for confounders, this became 2.07, 95 % CI 1.13, 3.79, $p = 0.02$. We conclude that microalbuminuria is more common in South Asians with Type 2 DM than in Europeans and, although risk factor relationships appeared similar in both groups, and some risk factors were more prominent in South Asians, this cannot account for the high prevalence of microalbuminuria observed in South Asians. © 1998 John Wiley & Sons, Ltd.

Diabet. Med. **15: 672–677 (1998)**

Received 23 January 1998; accepted 17 March 1998

Introduction

Type 2 (non-insulin-dependent) diabetes mellitus (Type 2 DM) is three to four times more common in South Asians than in Europeans within the UK.[1–5] However, relatively little is known about ethnic differences in diabetes-related complications. Morbidity and mortality risks from circulatory disease are markedly higher in South Asian than European diabetic people.[6,7] Diabetic nephropathy also appears to be more common in South Asians,[8,9] with acceptance rates for renal replacement therapy in the UK being nearly six times greater in South Asians with diabetes than in Europeans.[10] Microalbuminuria is both a marker for nephropathy in Type 2 DM and a remarkably potent prognostic indicator.[11–15] A higher prevalence of microalbuminuria in South Asian Type 2 DM patients compared with Europeans has been documented in two previous studies in relatively small patient groups[16,17] but this has not been confirmed in the large United Kingdom Prospective Diabetes Study (UKPDS).[18] There are distinct ethnic differences in the relationships between risk factors and cardiovascular disease,[5] which might also apply to albuminuria. However, the risk factors which may contribute to ethnic differences in nephropathy have not been examined in detail.

We have therefore studied the prevalence and associations of microalbuminuria in large, unselected groups of South Asian and European Type 2 DM patients attending a diabetes clinic in Southall, London, UK.

Patients and Methods

All South Asian and European Type 2 DM patients attending a diabetes follow-up clinic at Ealing Hospital over a 1-year period were included in the study. Patients were classified as having Type 2 DM if the age at diagnosis was 30 years or more, or if they were not on insulin. First morning urine samples were obtained by sending a container by post a few days before the clinic visit. The few patients who did not arrive with a sample were asked to provide a fresh sample at the clinic (all clinics were held in the morning). The samples were estimated for albumin using an in-house immunoturbidimetric method and for creatinine using a blanked

*Correspondence to: Dr H. Mather, Ealing Hospital, Uxbridge Road, Southall, Middlesex UB1 3HW, UK

 CCC 0742–3071/98/080672–06$17.50

Jaffe method, and the albumin/creatinine ratio (ACR) calculated. All specimens were tested for nitrites and leucocytes using Labstix and positive specimens were sent for microscopy and culture. Fasting venous blood samples were taken and estimated for HbA_1 using an automated HPLC method (reference range 5.0–9.0 %) and total serum cholesterol and triglyceride using an automated enzymatic method. HDL cholesterol was measured using a direct chromogenic assay. LDL cholesterol was calculated using the Friedewald formula.[19] Microalbuminuria was classified as an ACR > 2.5 in men and > 4.5 in women, and less than 250.[20] Patients were categorized as having clinical ischaemic heart disease (IHD) if they had a definite history of myocardial infarction or angina from review of the case-notes, and were classified as hypertensive if blood pressure was ≥ 95 mmHg diastolic, or ≥ 160 mm Hg systolic, or if they were on medication for hypertension.

The total number of patients attending the clinic over a 1-year period was 1835, of whom 38 were excluded because of evidence of urinary tract infection. Of the remaining 1797, 928 were South Asian, 697 were European, 164 were African Caribbean, and 8 were of other or mixed descent. Excluding 149 Type 1 diabetic patients from the combined European and South Asian group and 4 patients in whom diabetes type could not be assigned, we were left with 1472 patients (889 South Asian, 583 European), for analysis. Serum triglyceride, low density lipoprotein and HDL were only assayed in the first 245 (154 men and 91 women) South Asian and 145 (79 men and 66 women) European patients. An ACR above the microalbuminuric range was found in 5 Europeans, and 21 South Asians; these patients were excluded from any analyses dealing with the ACR.

Statistical Analysis

Since the mean ages of South Asians and Europeans were markedly different, all mean values for baseline demographic variables were adjusted for age, either using the least square means approach for continuous variables, or directly standardized for age using the study population as the standard for categorical variables. ACR and serum triglyceride were positively skewed and were log transformed for analysis, and thus the means presented for these variables are geometric means. Analysis of variance was used to test for statistical significance in continuous variables by ethnic group, and the chi-square test was used for categorical variables. Standardized regression effects for microalbuminuria were calculated by multiplying the beta regression coefficients obtained from logistic regression models by the standard deviation of each variable for continuous variables. This allows us to compare directly the relative impact on microalbuminuria of each of these variables by using a standardized measure. Regression effects for categorical variables were calculated and are expressed as the effect of the change by one unit of that variable. The standardized regression effects for variables which had been measured on all patients were similar to those for the subgroup on whom triglyceride, HDL and LDL cholesterol were available, and thus standardized regression effects are shown for as many people as possible who had the relevant variables measured. The odds ratios for microalbuminuria, adjusted for key risk factors as assessed by the standardized regression effects, were then calculated using logistic regression.

Results

South Asian men and women were significantly younger than their European counterparts, and their mean ages at diagnosis were also markedly lower (Table 1). Glycaemic control was significantly worse in South Asians than Europeans, mean HbA_1 concentrations being 0.4 % and 0.6 % higher in South Asian men ($p = 0.02$) and women ($p = 0.01$), respectively, than in their European counterparts. Retinopathy prevalence was higher, and significantly so in men, in South Asians compared to Europeans. South Asians were less likely to be on insulin, and more likely to be on oral medication, compared to Europeans. Mean blood pressure appeared to be lower in South Asian compared with European women, but the age standardized prevalence of hypertension was similar for the two ethnic groups. The prevalence of IHD was higher in South Asians than in Europeans (22 % vs 18 % $p = 0.04$ in men, and 19 % versus 14 % $p = 0.03$ in women). There were no significant ethnic differences between mean total cholesterol, triglyceride, HDL cholesterol or LDL cholesterol concentrations.

Mean ACR in South Asian men and women was significantly higher than in their European counterparts. The prevalence of microalbuminuria was significantly higher in South Asians than in Europeans, being 40 % and 33 % in South Asian and European men, respectively ($p = 0.003$), and 33 % and 19 % in South Asian and European women ($p < 0.0001$).

The proportions of men and women within each ethnic group were approximately similar, and the risk factors and their associations within each ethnic group did not differ by gender. We therefore combined both sexes to examine the ethnic differences in risk factor relationships, as shown in Table 2. Age and duration of diabetes were significantly related to ACR in both South Asians and Europeans. Other significant risk factors for both South Asians and Europeans included HbA_1, systolic and diastolic blood pressure, cholesterol, serum triglyceride, and the presence of hypertension or retinopathy. The strongest continuous risk factors for ACR, as assessed by the magnitude of the standardized regression effect, were systolic blood pressure, HbA_1, and triglyceride, and the strongest categorical variable was retinopathy.

The age and sex-adjusted odds ratio for microalbuminuria in South Asians compared with Europeans for all patients was 1.61 (95 % CI 1.26, 2.06, $p = 0.0001$, Table 3). The addition of all the other significant variables,

Table 1. Baseline characteristics by ethnic group and sex (mean or % ± standard error)

	Men			Women		
	European	South Asian	*p* value	European	South Asian	*p* value
Number	347	542		236	347	
Age (yr)	64 ± 0.6	58 ± 0.5	0.0001	68 ± 0.7	57 ± 0.6	0.0001
Duration of diabetes (yr)	9 ± 0.4	9 ± 0.3	0.09	9 ± 0.5	9 ± 0.4	0.7
Age at diagnosis (yr)	54 ± 0.6	48 ± 0.5	0.0001	58 ± 0.8	48 ± 0.7	0.0001
HbA_1 (%)[a]	10.9 ± 0.1	11.3 ± 0.1	0.02	11.3 ± 0.2	11.9 ± 0.1	0.01
Systolic BP (mmHg)[a]	139 ± 1	139 ± 1	0.7	146 ± 2	139 ± 1	0.004
Diastolic BP (mmHg)[a]	77 ± 1	77 ± 1	0.4	76 ± 1	73 ± 1	0.02
BMI (kg m^{-2})[a]	28.8 ± 0.3	26.7 ± 0.2	0.0001	29.6 ± 0.4	28.3 ± 0.3	0.01
Total cholesterol (mmol l^{-1})[a]	5.45 ± 0.06	5.52 ± 0.05	0.4	5.20 ± 0.08	5.81 ± 0.06	0.3
HDL cholesterol (mmol l^{-1})[a]	1.12 ± 0.04	1.10 ± 0.03	0.7	1.33 ± 0.05	1.24 ± 0.04	0.2
LDL cholesterol (mmol l^{-1})[a]	3.48 ± 0.13	3.60 ± 0.09	0.4	3.88 ± 0.15	3.59 ± 0.13	0.2
Triglyceride (mmol l^{-1})[a]	1.83 (1.60,2.11)	1.97 (1.79,2.18)	0.4	1.86 (1.62,2.13)	2.10 (1.86,2.36)	0.2
A/C ratio[a]	1.95 (1.67,2.29)	2.40 (2.14,2.71)	0.04	2.05 (1.69,2.50)	2.89 (2.47,3.38)	0.01
Microalbuminuric (%)[a]	33 ± 2.6	40 ± 2.1	0.003	19 ± 2.6	33 ± 2.8	< 0.0001
Smoker (%)[a]	16 ± 2.0	12 ± 1.4	0.02	12 ± 2.4	2 ± 0.9	< 0.0001
Hypertensive (%)[a]	38 ± 2.6	38 ± 2.1	0.7	40 ± 3.4	39 ± 2.8	0.8
Previous IHD (%)[a]	18 ± 2.0	22 ± 1.8	0.04	14 ± 2.5	19 ± 2.3	0.03
Retinopathy (%)[a]	22 ± 2.1	29 ± 2.0	< 0.0001	25 ± 2.8	26 ± 2.6	0.7
Insulin treated (%)[a]	28 ± 2.5	23 ± 1.8	0.04	32 ± 3.4	23 ± 2.4	0.01

[a]Age adjusted (continuous variables) or age standardized (categorical variables), geometric means and 95 % CI for ACR and triglyceride.

Table 2. Standardized regression effects adjusted for age and sex, 95 % confidence intervals and p values examining the relationship between risk factors and microalbuminuria

Variable	European	South Asian
Age	1.45 (1.14, 1.86) 0.0002	1.39 (1.20, 1.62) 0.0001
Duration of diabetes	1.23 (1.09, 1.42) 0.02	1.47 (1.30, 1.66) 0.0001
Age at diagnosis	1.27 (1.05, 1.53) 0.02	1.10 (0.95, 1.28) 0.2
HbA_1	1.43 (1.19, 1.72) 0.0002	1.64 (1.43, 1.89) 0.0001
Systolic BP (mmHg)	1.38 (1.13, 1.67) 0.001	1.34 (1.16, 1.55) 0.0001
Diastolic BP (mmHg)	1.31 (1.08, 1.59) 0.005	1.19 (1.03, 1.38) 0.02
Total cholesterol (mmol l^{-1})	1.16 (0.96, 1.40) 0.1	1.20 (1.03, 1.38) 0.02
Log triglyceride (mmol l^{-1})	3.17 (1.87, 5.36) 0.0001	1.55 (1.17, 2.06) 0.003
HDL cholesterol (mmol l^{-1})	0.41 (0.24, 0.70) 0.001	0.83 (0.62, 1.11) 0.2
LDL cholesterol (mmol l^{-1})	1.05 (0.68, 1.62) 0.06	1.37 (1.03, 1.85) 0.03
Sex (female versus male)	0.46 (0.31, 0.68) 0.0001	0.71 (0.53, 0.95) 0.02
Smoker	0.93 (0.53, 1.63) 0.07	1.16 (0.68, 1.96) 0.6
Hypertensive	1.80 (1.24, 2.61) 0.002	1.60 (1.19, 2.14) 0.002
Previous MI	1.25 (0.78, 2.00) 0.3	1.01 (0.70, 1.47) 1.00
Retinopathy	1.75 (1.16, 2.64) 0.009	2.99 (2.14, 4.18) 0.0001
Insulin versus diet treatment	1.11 (0.56, 2.19) 0.8	3.61 (1.93, 6.71) 0.0001
Oral versus diet treatment	1.25 (0.67, 2.33) 0.5	2.30 (1.30, 4.05) 0.004

Table 3. Risk (odds ratio) of microalbuminuria in South Asians versus Europeans with adjustment for confounders

	All patients			Subgroup with triglyceride measurements		
	Odds ratio	95 % CI	p value	OR	95 % CI	p value
Basic model[a]	1.61	1.26, 2.06	0.0001	1.78	1.02, 2.82	0.02
Duration	1.49	1.15, 1.92	0.003	1.69	1.02, 2.82	0.05
HbA_1	1.55	1.20, 1.99	0.0007	1.79	1.07, 2.97	0.03
Systolic BP	1.68	1.31, 2.16	0.0001	1.90	1.15, 3.13	0.01
BMI	1.76	1.35, 2.29	0.0001	2.18	1.29, 3.70	0.004
Retinopathy	1.60	1.24, 2.06	0.0003	1.68	1.01, 2.79	0.05
Treatment type	1.65	1.28, 2.11	0.0001	1.77	1.08, 2.88	0.02
Triglyceride	–	–	–	1.77	1.08, 2.88	0.03
All variables	1.65	1.23, 2.21	0.0008	2.07	1.13, 3.79	0.02

[a]Basic model includes age and sex only, subsequent models add variable to this basic model.

namely duration of diabetes, HbA_1, systolic blood pressure, body mass index, treatment type and presence of retinopathy, to the model barely altered the odds ratio (1.65, 95 % CI 1.23, 2.21, $p = 0.008$). In the subgroup who had a triglyceride measurement, the sex- and age-adjusted odds ratios for microalbuminuria in South Asians compared to Europeans was 1.78 (95 % CI 1.02, 2.82, $p = 0.02$). The addition of all other potential confounders and triglyceride within this group increased the odds ratio to 2.07 (95 % CI 1.13, 3.79, $p = 0.02$). There was no evidence of any interactions between risk factors and ethnicity on the risk of albuminuria.

Discussion

This large cross-sectional study confirms the high burden of renal disease in South Asian subjects with Type 2 DM compared with Europeans. The prevalence of microalbuminuria in South Asian men and women was increased by 1.2- and 1.7-fold, respectively. This is consistent with previous reports from relatively small groups of South Asian patients in the UK.[16,17,21] By contrast, the prevalence of albuminuria was virtually identical in South Asians and European Type 2 DM patients in the UKPDS,[18] but selection biases within their cohort may have produced misleading findings, since only newly diagnosed patients without severe complications were included.

The close relationship between the development of microalbuminuria and poor glycaemic control has been conclusively demonstrated in subjects with Type 1 diabetes in the Diabetes Control and Complications Trial.[22] The relationship within Type 2 DM is less well established. Most cross-sectional studies have shown a close correlation between glycaemic control and albuminuria,[23] but this has not been confirmed in more recent prospective studies.[24] In the current study, glycaemic control was significantly worse in South Asians than in Europeans, providing a possible explanation for their higher prevalence of microalbuminuria. However, the increased risk of microalbuminuria in the South Asian people persisted after adjustment for differences in glycaemic control. Similarly, adjustment for other factors which were strongly associated with the risk of microalbuminuria, such as systolic blood pressure, duration of diabetes or retinopathy, had little effect on the increased odds ratio for microalbuminuria observed in the South Asians.

It has been proposed that microalbuminuria is a component of the insulin resistance syndrome,[25,26] and it has been demonstrated that South Asian people exhibit classical features of this entity, such as hyperinsulinaemia, glucose intolerance, and lipid disturbances.[5] Our data show that triglyceride concentration is strongly related to ACR in this population, and others have also shown it to be one of the strongest determinants of progression of albumin excretion rate.[24] However, adjustment for differences in triglyceride could not account for the raised prevalence of microalbuminuria observed in the South Asian Type 2 DM patients.

If standard environmental risk factors cannot account for the high risk of microalbuminuria in ethnic minority groups, other explanations need to be sought. A recent review[23] highlighted the high prevalence of microalbuminuria observed in several non-European groups throughout the world, including Pima Indians,[27] Mexican Americans,[28] African Americans,[29] and Saudi Arabians.[30] These observations may be consistent with a genetic susceptibility to diabetic nephropathy,[31] although extensive searches have failed to identify the genes responsible.

Clinic-based studies are open to criticism because they may not be representative of the general population with diabetes. In the population-based Southall Diabetes Survey[1] undertaken locally, 71 % patients who said they had diabetes attended a hospital clinic (predominantly Ealing Hospital), and this proportion did not differ significantly by ethnic group. To negate our findings of an approximately 50 % increased risk of microalbuminuria in South Asian Type 2 DM patients, the prevalence in those treated solely within the community would need to be about half that in South Asians compared to Europeans. This large reversal in risk seems inherently improbable. Further, we were especially interested in risk factor relationships for microalbuminuria in the two ethnic groups. It would be difficult to hypothesize a scenario where, for example, triglyceride was negatively associated with ACR in community paients, but was strongly positively correlated to ACR in those attending the hospital clinic.

We used an early morning sample of urine to calculate ACR, rather than measuring a 24 h albumin excretion rate. We chose this method of assessment of albuminuria because it is more acceptable to large patient groups, and previous studies indicate that as many as 30 % of patients refuse or fail to complete a 24 h urine collection.[32] The correlation between an early morning ACR and 24 h albumin excretion rate is remarkably good.[32]

The raised prevalence of microalbuminuria in South Asian Type 2 DM patients is important because it is a marker both of circulatory disease and end-stage nephropathy.[11–15] We were, however, unable to demonstrate a relationship between ACR and clinical IHD. This may be related to the cross-sectional nature of our study, which limits it to survivors. A prospective study following patients from diagnosis might demonstrate a different relationship. This is supported by the results from a recent 11-year population-based prospective study of people with diabetes identified in the Southall survey, which demonstrated a two-fold increase in mortality and morbidity from IHD in middle-aged South Asians compared to Europeans, with the greatest risk differences occurring at relatively young ages.[6] These striking data will reinforce attempts to intervene in this vulnerable patient group with evidence-based measures, including aspirin and lipid-lowering agents and angiotensin converting enzyme inhibitors.[33]

We conclude firstly that the risk of microalbuminuria is greater in South Asian people with Type 2 DM than in European diabetic patients, and secondly that conventional risk factors, particularly glycaemic control, blood pressure, and triglyceride, which may be particularly elevated in South Asians, cannot account for the observed high prevalence. Given the importance of microalbuminuria as a prognostic marker for morbidity and mortality, further work is required to understand the reasons for the high risks of renal disease in this population, so that the inexorable progression to end-stage renal disease can be avoided. The examination of these risks should also include an assessment of genetic

markers, which may assist in our understanding of diabetic nephropathy in all ethnic groups.

References

1. Mather HM, Keen H. The Southall Diabetes Survey: prevalence of known diabetes in Asians and Europeans. *Br Med J* 1985; **291**: 1081–1084.
2. Cruickshank JK. Diabetes: contrasts between peoples of black (West African), Indian and white European origin. In: Cruickshank JK, Beevers DG, eds. *Ethnic Factors in Health and Disease*. Oxford: Butterworths, 1989: 289–304.
3. Samanta A, Burden AC, Fent B. Comparative prevalence of non-insulin-dependent diabetes mellitus in Asian and White Caucasian adults. *Diabetes Res Clin Pract* 1987; **4**: 1–6.
4. Simmons D, Williams DRR, Powell MJ. Prevalence of diabetes in a predominantly Asian community: preliminary findings of the Coventry diabetes study.*Br Med J* 1989; **298**: 18–21.
5. McKeigue PM, Shah B, Marmot MG. Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians. *Lancet* 1991; **337**: 382–386.
6. Mather HM, Chaturvedi N, Fuller JH. Mortality and morbidity from diabetes in South Asians and Europeans: 11-year follow-up of the Southall Diabetes Survey. *Diabetic Med* 1998; **15**: 53–59.
7. Chaturvedi N, Fuller J. Ethnic differences in mortality from cardiovascular disease in the UK: do they persist in people with diabetes? *J Epidemiol Community Health* 1996; **50**: 137–139.
8. Burden AC, McNally PG, Feehally J, Walls J. Increased incidence of end stage renal failure secondary to diabetes mellitus in Asian ethnic groups in the United Kingdom. *Diabetic Med* 1992; **9**: 641–645.
9. Samanta A, Burden AC, Jagger C. A comparison of the clinical features and vascular complications of diabetes between migrant Asians and Caucasians in Leicester, UK. *Diabetes Res Clin Pract* 1991; **14**: 205–213.
10. Roderick PJ, Raleigh VS, Hallam L, Mallick NP. The need and demand for renal replacement therapy amongst ethnic minorities in England. *J Epidemiol Community Health* 1996; **50**: 334–339.
11. Mogensen CE. Microalbuminuria predicts clinical proteinuria and early mortality in maturity-onset diabetes. *N Engl J Med* 1984; **310**: 356–360.
12. Jarrett RJ, Viberti GC, Argyropoulos A, Hill RD, Mahmud U, Murrells TJ. Microalbuminuria predicts mortality in non-insulin-dependent diabetes. *Diabetic Med* 1984; **1**: 17–19.
13. Beatty OL, Ritchie CM, Bell PM, Hadden DR, Kennedy L, Atkinson AB. Microalbuminuria as identified by a spot morning urine specimen in non-insulin-treated diabetes: an eight-year follow-up study. *Diabetic Med* 1995; **12**: 261–266.
14. MacLeod JK, Lutale J, Marshall SM. Albumin excretion rate and vascular deaths in NIDDM. *Diabetologia* 1995; **38**: 610–616.
15. Niskanen LK, Pentilla I, Parviainen M, Uusitupa MI. Evolution, risk factors, and prognostic implications of albuminuria in NIDDM. *Diabetes Care* 1996; **19**: 486–493.
16. Allawi J, Rao PV, Gilbert R, Scott G, Jarrett RJ, Keen H, *et al*. Microalbuminuria in non-insulin-dependent diabetes: its prevalence in Indian compared with Europid patients. *Br Med J* 1988; **296**: 462–464.
17. Tindall H, Martin P, Nagi D, Pinnock S, Stickland M, Davies JA. Higher levels of microproteinuria in Asian compared with European patients with diabetes mellitus and their relationship to dietary protein intake and diabetic complications. *Diabetic Med* 1994; **11**: 37–41.
18. UK Prospective Diabetes Study Group. UK Prospective Diabetes Study Paper XII: Differences between Asian, Afro-Caribbean and White Caucasian Type 2 diabetic patients at diagnosis of diabetes. *Diabetic Med* 1994; **11**: 670–677.
19. Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of low-density lipoprotein cholesterol in plasma without use of the preparative ultracentrifuge. *Clin Chem* 1972; **18**: 499–502.
20. Connell SJ, Hollis S, Tieszen KL, McMurray JR, Dornan TL. Gender and the clinical usefulness of the albumin:creatinine ratio. *Diabetic Med* 1994; **11**: 32–36.
21. Samanta A, Burden AC, Feehally J, Walls J. Diabetic renal disease: differences between Asians and white Caucasians. *Br Med J* 1986; **293**: 366–367.
22. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *N Engl J Med* 1993; **329**: 977–986.
23. Alzaid AA. Microalbuminuria in patients with NIDDM: an overview. *Diabetes Care* 1996; **19**: 79–89.
24. Smulders YM, Rakic M, Stehouwer CDA, Weijers RNM, Slaats EH, Silberbusch J. Determinants of progression of microalbuminuria in patients with NIDDM: a prospective study. *Diabetes Care* 1997; **20**: 999–1005.
25. Niskanen L, Laakso M. Insulin resistance is related to albuminuria in patients with type II (non-insulin-dependent) diabetes mellitus. *Metabolism* 1993; **42**: 1541–1545.
26. Groop L, Ekstrand A, Forsblom C, Widen E, Groop PH, Teppo AM, *et al*. Insulin resistance, hypertension and microalbuminuria in patients with type 2 (non-insulin-dependent) diabetes mellitus. *Diabetologia* 1993; **36**: 642–647.
27. Nelson RG, Kunzelman CL, Pettitt DJ, Saad MF, Bennett PH, Knowler WC. Albuminuria in type 2 (non-insulin-dependent) diabetes mellitus and impaired glucose tolerance in Pima Indians. *Diabetologia* 1989; **32**: 870–876.
28. Haffner SM, Mitchell BD, Pugh JA, Stern MP, Kozlowski MK, Hazuda HP, *et al*. Proteinuria in Mexican Americans and non-Hispanic whites with NIDDM. *Diabetes Care* 1989; **12**: 530–536.
29. Dasmahapatra A, Bale A, Raghuwanshi MP, Reddi A, Byrne W, Suarez S, *et al*. Incipient and overt diabetic nephropathy in African Americans with NIDDM. *Diabetes Care* 1994; **17**: 297–303.
30. Alzaid A, Sobki S, De Silva V. Prevalence of microalbuminuria in Saudi Arabians with NIDDM: a clinic based study. *Diabetes Res Clin Pract* 1994; **26**: 115–120.
31. Chowdhury TA, Kumar S, Barnett AH, Bain SC. Nephropathy in type I diabetes: the role of genetic factors. *Diabetic Med* 1995; **12**: 1059–1067.
32. Gatling W, Knight C, Hill RD. Screening for early diabetic nephropathy: which sample to detect micro-albuminuria? *Diabetic Med* 1985; **2**: 451–455.
33. Yudkin JS, Blauth C, Drury P, Fuller J, Henley J, Lancaster T, *et al*. Prevention and management of cardiovascular disease in patients with diabetes mellitus: an evidence base. *Diabetic Med* 1996; **13**: S101–S121.

